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(54) **APPLIANCE PUMP WITH ANGLED FLOW PATH AND AXIAL FLOW IMPELLER**

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F04D 29/60	(2006.01)
F04D 29/40	(2006.01)
F04D 25/06	(2006.01)
F04D 29/52	(2006.01)

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(58) **Field of Classification Search**

CPC F04D 3/00; F04D 3/005; F04D 13/06; F04D 13/0606; F04D 13/0666; F04D 13/08; F04D 25/0606; F04D 25/0653; F04D 25/0686; F04D 29/181; F04D 29/183; F04D 29/406; F04D 29/52; F04D 29/528; F04D 29/605; F04D 29/64; F04D 29/648; F04D 13/0653; F04D 13/086; F04D 29/548; F04D 29/56; F04D 29/566; F04D 29/007

See application file for complete search history.

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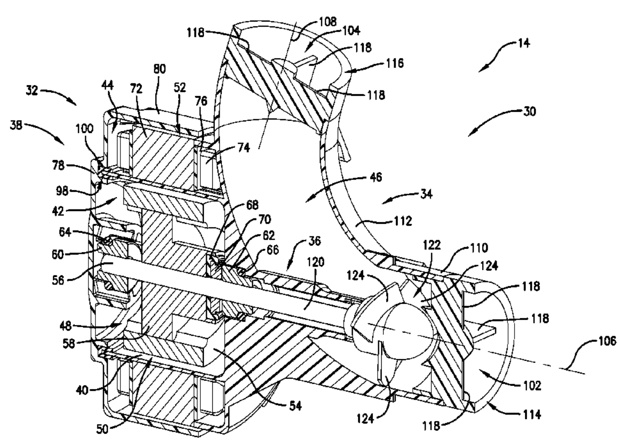
(57) **ABSTRACT**

A household appliance includes a tub, in which a liquid is at least temporarily contained, and a pump assembly for effecting liquid flow within the tub. The pump assembly includes a housing including an integrally formed flow path portion defining an inlet, an outlet, and a flow path extending between and interconnecting the inlet and the outlet. The flow path portion defines a turn, such that part of the flow path extends in a direction oriented at an angle relative to the inlet axis. The pump assembly includes a rotatable impeller. The impeller includes a plurality of blades extending at least substantially radially from the impeller axis and configured to propel a fluid at least substantially axially thereby. The impeller is positioned in the flow path adjacent the inlet such that the impeller axis and the inlet axis are at least substantially parallel or at least substantially aligned.

22 Claims, 5 Drawing Sheets



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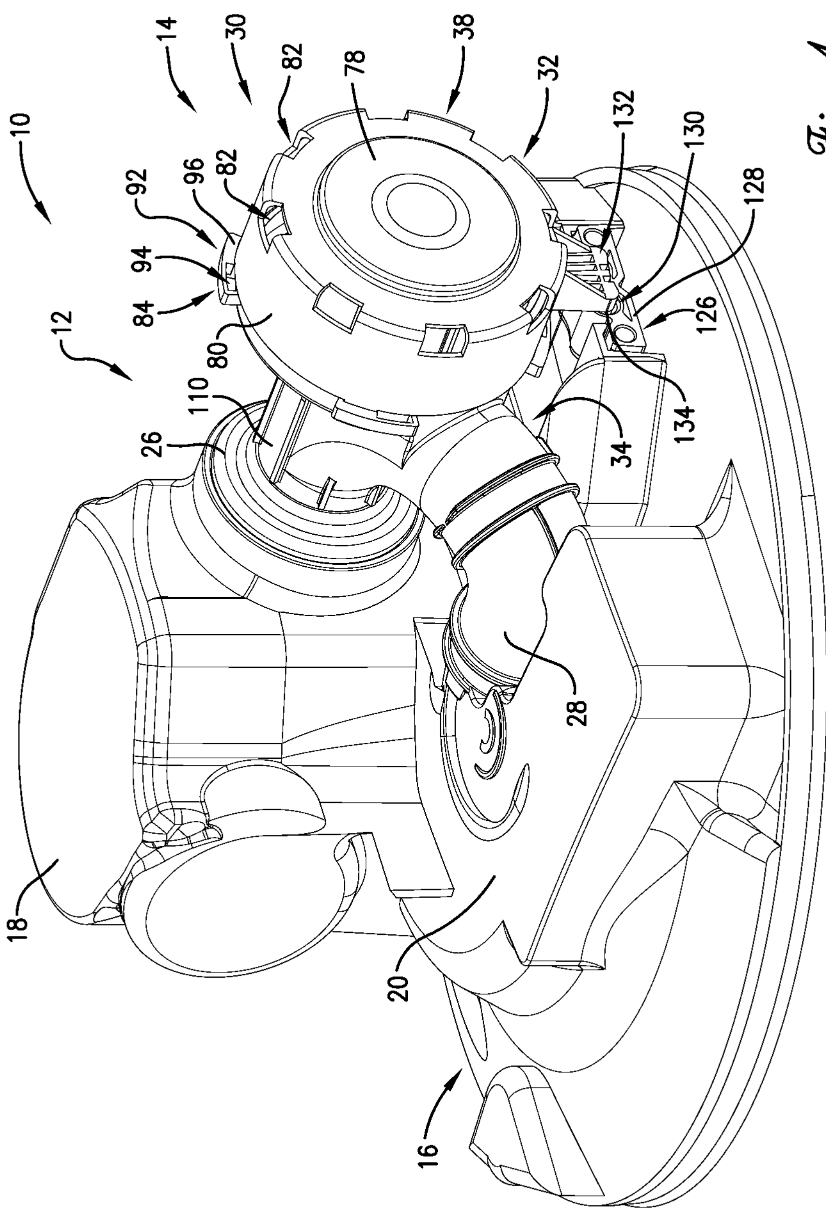
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Fig. 1.

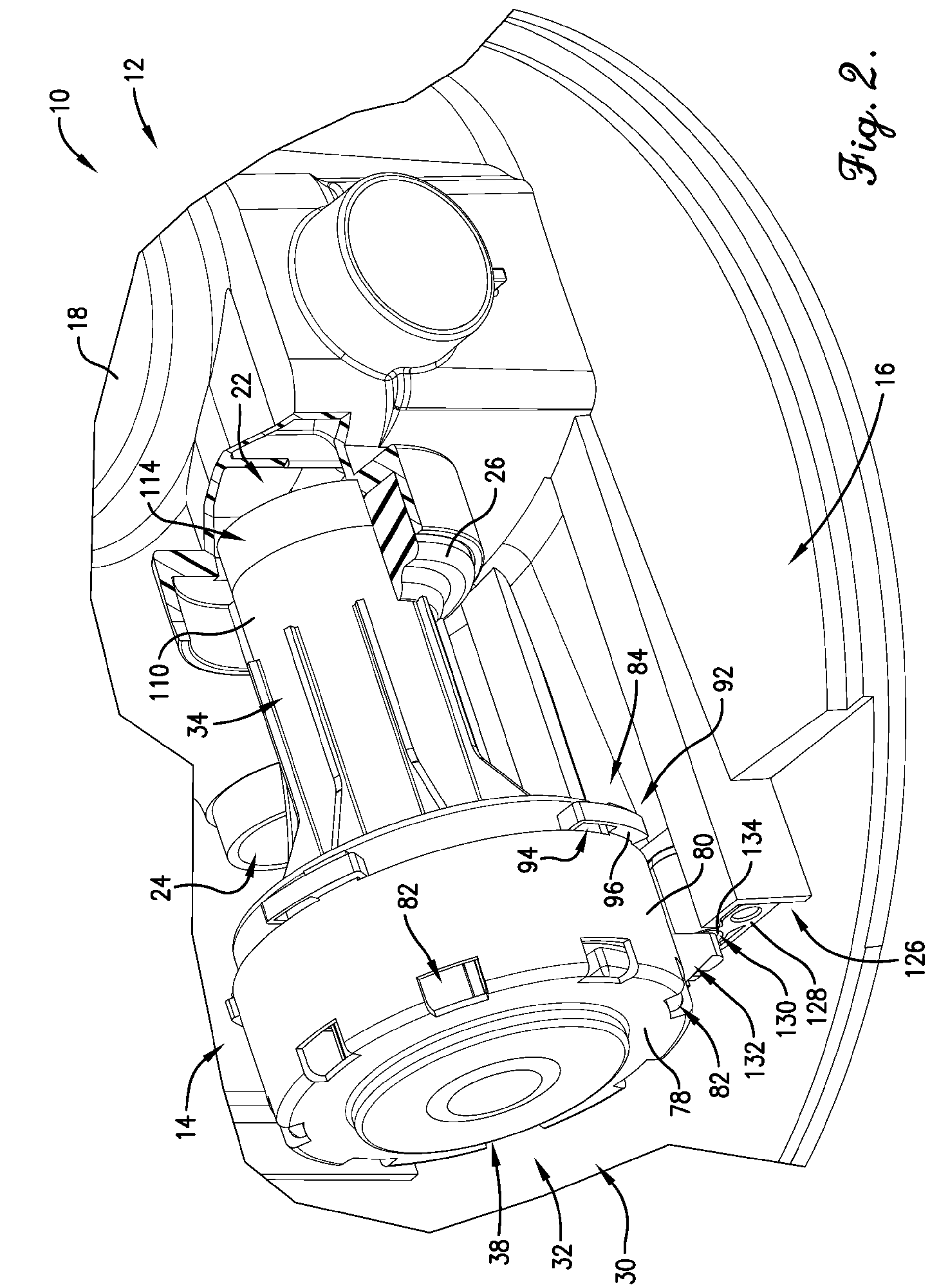
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Fig. 2.

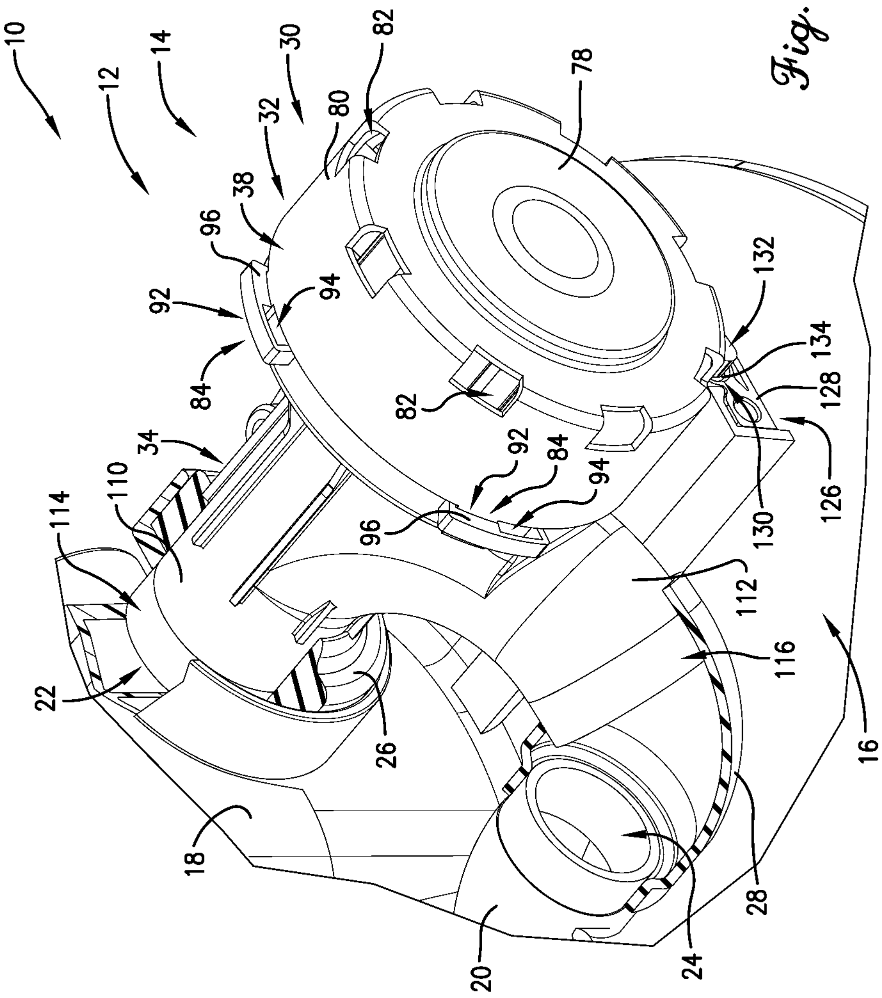
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Fig. 3.

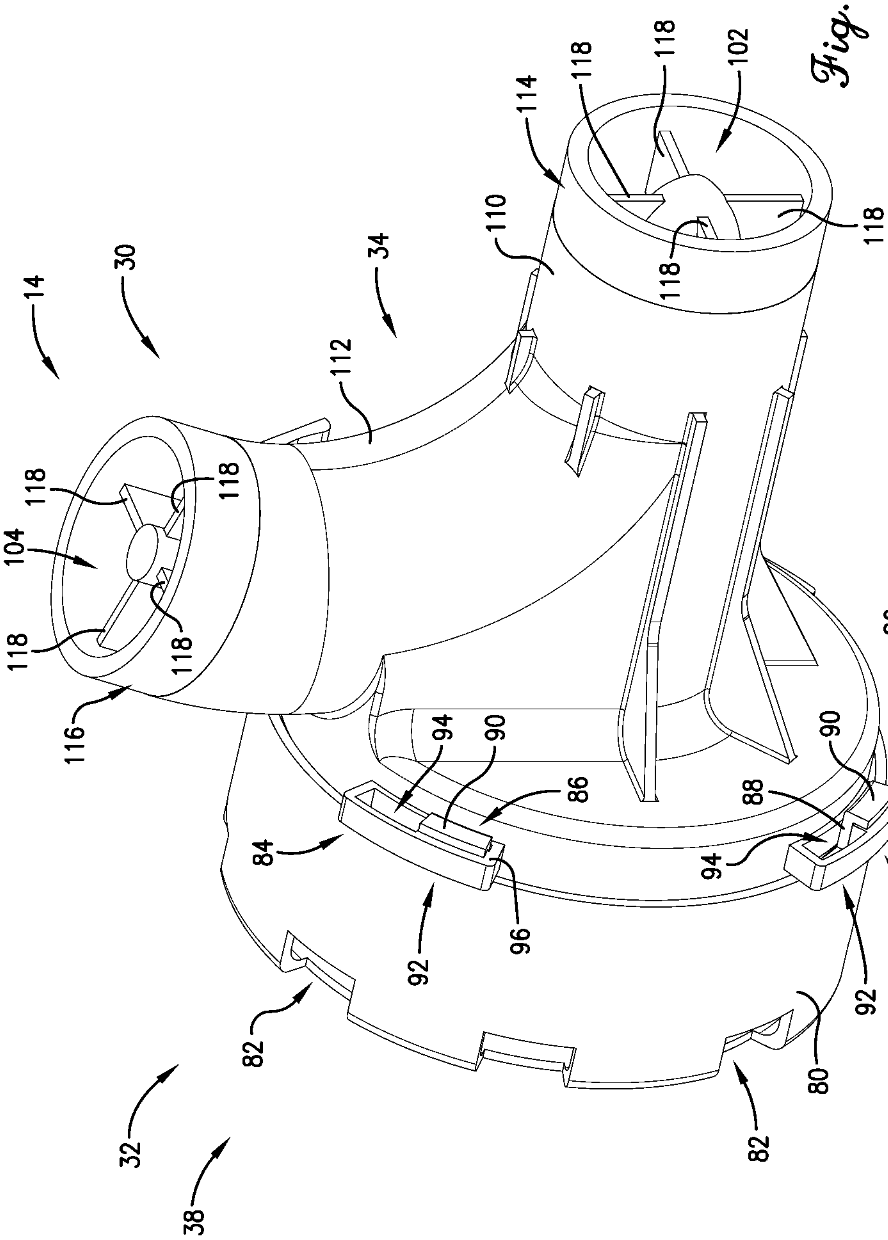

Fig. 4.

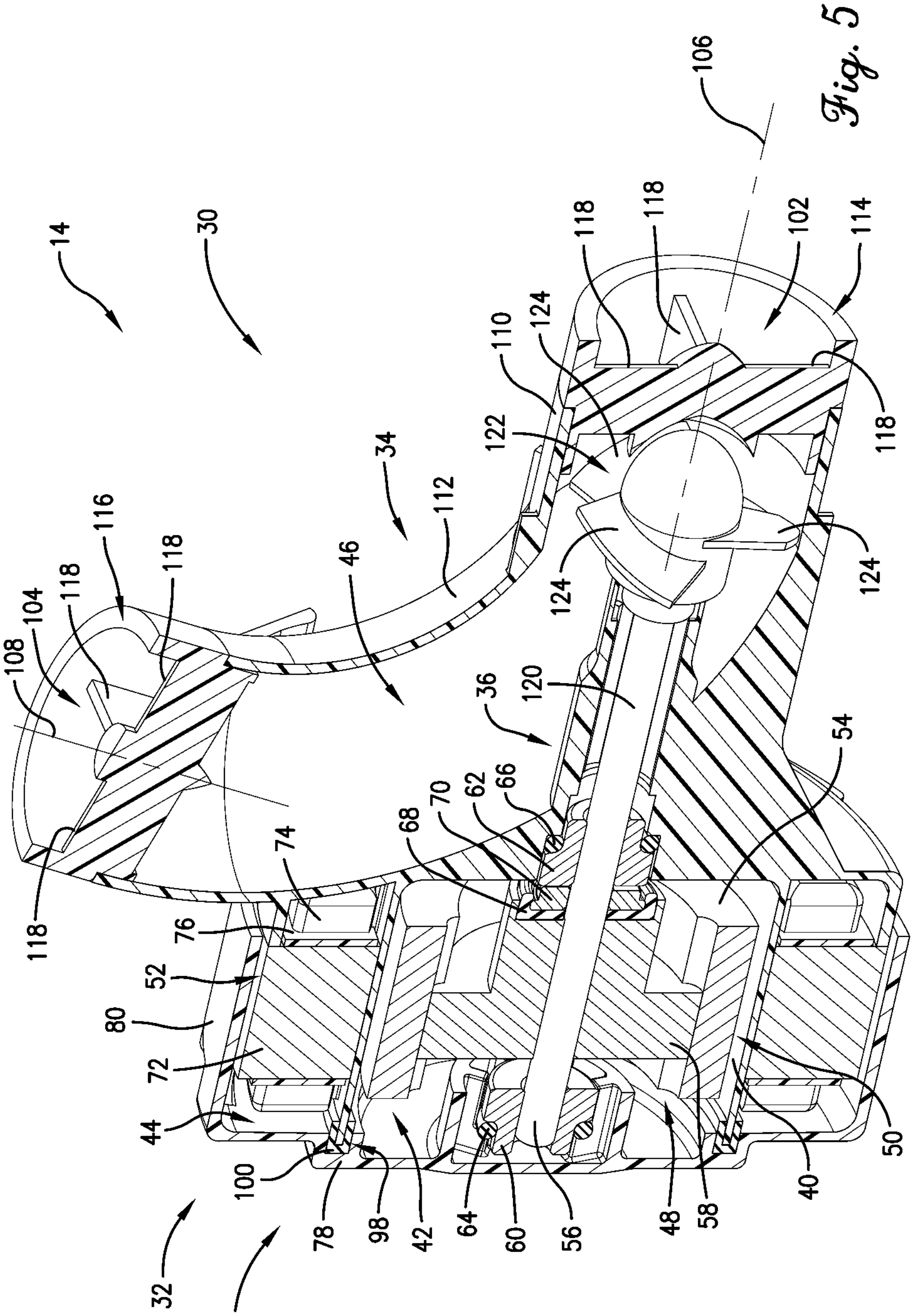
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Fig. 5

APPLIANCE PUMP WITH ANGLED FLOW PATH AND AXIAL FLOW IMPELLER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/723,253, filed Nov. 6, 2012, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a household appliance and a pump for effecting liquid flow within a tub of the appliance. More particularly, the pump has an axial flow impeller and includes a turn in the flow path between the inlet and outlet.

2. Discussion of the Prior Art

Those of ordinary skill in the art will appreciate that pumps are often used in home appliances such as dishwashers and washing machines. Such appliances are typically designed to meet certain space requirements, with such space requirements often resulting in consequential size and shape limitations being placed on components thereof. For instance, size and shape limitations placed on pumps of such appliances may at least in part dictate both the type of pump to be used (e.g., a radial-flow centrifugal pump) and the size of the selected pump. Since performance characteristics often vary based on pump size and type, the performance of the appliance as a whole may thus be affected by the size and shape limitations placed on the components.

SUMMARY

According to one aspect of the present invention, a household appliance is provided. The appliance comprises a tub in which a liquid is at least temporarily contained and a pump assembly for effecting liquid flow within the tub. The pump assembly includes a housing, a motor, and an impeller. The housing includes a motor portion and a flow path portion. The flow path portion is integrally formed and defines an inlet, an outlet, and a flow path extending between and interconnecting the inlet and the outlet. At least one of the inlet and the outlet is fluidly coupled to the tub. The flow path extends along an inlet axis adjacent the inlet and along an outlet axis adjacent the outlet. The flow path portion defines a turn, such that at least part of the flow path extends in a direction that is oriented at an angle relative to the inlet axis. The motor includes a rotor and a stator, with the stator being fixed relative to the motor portion. The impeller is rotatable about an impeller axis. The impeller includes a plurality of blades extending at least substantially radially from the impeller axis and configured to propel a fluid at least substantially axially thereby. The impeller is positioned in the flow path adjacent the inlet such that the impeller axis and the inlet axis are at least substantially parallel or at least substantially aligned.

According to another aspect of the present invention, an appliance pump assembly for effecting liquid flow within a tub of the appliance is provided. The pump assembly comprises a housing, a motor, and an impeller. The housing includes a motor portion and a flow path portion. The flow path portion is integrally formed and defines an inlet, an outlet, and a flow path extending between and interconnecting the inlet and the outlet. At least one of the inlet and the outlet is configured for fluid connection to the tub. The flow path extends along an inlet axis adjacent the inlet and along an outlet axis adjacent the outlet. The flow path portion defines a turn, such that at least part of the flow path extends in a direction that is oriented at an angle relative to the inlet axis. The motor includes a rotor and a stator, with the stator being fixed relative to the motor portion. The impeller is rotatable about an impeller axis. The impeller includes a plurality of blades extending at least substantially radially from the impeller axis and configured to propel a fluid at least substantially axially thereby. The impeller is positioned in the flow path adjacent the inlet such that the impeller axis and the inlet axis are at least substantially parallel or at least substantially aligned.

This summary is provided to introduce a selection of concepts in a simplified form. These concepts are further described below in the detailed description of the preferred embodiments. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

Various other aspects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiments and the accompanying drawing figures.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Preferred embodiments of the present invention are described in detail below with reference to the attached drawing figures, wherein:

FIG. **1** is a bottom perspective view of a portion of a dishwasher constructed in accordance with the principles of a preferred embodiment of the present invention, particularly illustrating a sump and an associated pump;

FIG. **2** is an enlarged, fragmented view of the dishwasher portion of FIG. **1**, particularly illustrating the pump inlet connection to the sump;

FIG. **3** is an enlarged, fragmented view of the dishwasher portion of FIG. **1**, particularly illustrating the pump inlet and outlet connections to the sump;

FIG. **4** is an enlarged perspective view of the pump of FIG. **1**; and

FIG. **5** is a cross-sectional view of the pump of FIG. **5**, particularly illustrating the relative positioning of the inlet, the outlet, the impeller, the shaft, and the rotor.

The drawing figures do not limit the present invention to the specific embodiments disclosed and described herein. The drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the preferred embodiments.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is susceptible of embodiment in many different forms. While the drawings illustrate, and the specification describes, certain preferred embodiments of the invention, it is to be understood that such disclosure is by way of example only. There is no intent to limit the principles of the present invention to the particular disclosed embodiments.

With initial reference to FIG. **1**, a portion of a household appliance **10** is shown. In the illustrated embodiment, the appliance **10** is a dishwasher. However, it is permissible according to some aspects of the present invention for the appliance to be another type of household appliance, such as a washing machine.

As shown in FIG. **1**, the appliance **10** preferably includes a tub **12** in which a fluid (or, more preferably, a liquid) is at least temporarily contained and a pump assembly **14** configured to effect fluid flow (or, more preferably, liquid flow) within the tub **12**. In a preferred dishwasher embodiment, the tub **12** is preferably part of or positioned adjacent a dish chamber (not shown) containing or configured to contain dishes (not shown) to be washed. However, alternative tub arrangements and/or function are permissible.

Preferably, the tub **12** includes a sump **16** at its bottom end. Among other things, the sump **16** preferably includes a drainage basin **18** and a sprayer supply channel **20**. In a preferred dishwasher embodiment, the drainage basin **18** preferably receives fluid from the dish chamber, while the sprayer supply channel **20** preferably supplies fluid to a plurality of sprayer arms (not shown) configured to direct the fluid onto the dishes in the dish chamber. However, it is permissible for the sump to include a variety of additional and/or alternative components.

As best shown in FIGS. **2** and **3**, the appliance **10** preferably defines a supplying orifice **22** and a receiving orifice **24**. As will be discussed in greater detail below, the supplying orifice **22** is preferably configured to direct fluid to the pump assembly **14**, while the receiving orifice **24** is preferably configured to receive fluid from the pump assembly **14**.

In a preferred embodiment, the supplying orifice **22** is adjacent the drainage basin **18** and in fluid communication therewith, such that fluid from the drainage basin **18** is supplied to the pump assembly **14** via the supplying orifice **22**. Furthermore, the receiving orifice **24** is preferably adjacent the sprayer supply channel **20** such that fluid from the pump assembly **14** is supplied to the sprayer supply channel **20** via the receiving orifice **24**.

However, it is permissible for the supplying orifice and the receiving orifice to be alternatively positioned or defined. It is also permissible for some or all of the flow to be diverted from the flow path described above. For instance, some or all of the fluid entering the drain chamber might in some cases be diverted away from the supplying orifice, such that the fluid is not recirculated by the pump assembly **14** and the sprayer arms.

It is also permissible for the flow direction be opposite of that described above, such that what is referred to herein as the supplying orifice actually receives fluid and what is referred to herein as the receiving orifice actually supplies fluid. The flow direction may also be reversible, such that each orifice both supplies and receives fluid as dictated by the flow direction.

In a preferred embodiment, the pump assembly **14** is fluidly coupled to the tub **12** and, more particularly, to the sump **16** via an inlet connector **26** and an outlet connector **28**. Preferably, the inlet connector **26** extends at least substantially linearly between the supplying orifice **22** and the pump assembly **14**, while the outlet connector **28** extends in a curved manner to form an elbow between the pump assembly **14** and the receiving orifice **24**. However, it is permissible for connectors of any shape or size to be used or for only one of the inlet and the outlet to be fluidly coupled to the tub. For instance, the inlet might be coupled to the tub, while the outlet might be coupled to a drainage line configured to direct fluid to a location remote from the appliance.

Preferably, the connectors **26** and **28** comprise a water-resistant material. More preferably, the connectors **26** and **28** comprise a rubber material. However, any one or more of a variety of materials may be used.

Preferably, the connectors **26** and **28** form an at least substantially fluid-tight seal with associated portions of the pump assembly **14** and the sump **16**, such that fluid loss associated with connection of the pump assembly **14** to the sump **16** is minimized. However, seal quality may vary.

Preferably, the connectors **26** and **28** are at least substantially flexible to aid in assembly of the appliance **10**. However it is permissible for rigid connectors to be used. Furthermore, it is permissible for additional connectors to be provided or for individual ones of the connectors to comprise a plurality of segments.

As best shown in FIGS. **4** and **5**, the pump assembly **14** preferably includes a housing **30** including a motor portion **32**, a flow path portion **34**, and a sheath portion **36**. As will be discussed in greater detail below, the motor portion **32** preferably includes a cover **38** and a partition **40** that cooperatively define a rotor compartment **42** and a stator compartment **44**, while the flow path portion **34** preferably defines a flow path **46**.

Preferably, the housing **30** comprises plastic, although any one or more of a variety of materials may be used without departing from the scope of the present invention.

As shown in FIG. **5**, the pump assembly **14** preferably includes a motor **48** including a rotor **50** and a stator **52**. The rotor **50** is preferably rotatably disposed in the rotor compartment **42**, while the stator **52** is preferably disposed in the stator compartment **44** and fixed to the housing **30**.

In a preferred embodiment, the motor **48** is a wet rotor motor. More particularly, the rotor compartment **42** is preferably spaced from but fluidly connected to the flow path **46** so as to present a wet rotor design. However, it is permissible according to some aspects of the present invention for the motor to include mechanical face seals or other structures designed to limit or at least substantially restrict the ingress of fluid into the rotor compartment.

In a preferred embodiment, the motor **48** is a three-phase motor. However, according to some aspects of the present invention, the motor may alternatively be a two-phase motor, a single phase motor, or any of a variety of other types of motors known in the art.

It is also preferable that the motor **48** be a brushless permanent magnet (BPM) motor. However, according to some aspects of the present invention, the motor may be any type of motor, including but not limited to a permanent-split capacitor motor, a split phase motor, a synchronous motor, a switched reluctance motor, or a controlled induction motor.

The motor **48** is preferably a variable speed motor, although it is permissible according to some aspects of the present invention for the motor to be a fixed speed motor.

In a preferred embodiment, the motor **48** is configured to run at a specific speed of 5000 or greater. However, it is permissible according to some aspects of the present invention for the motor to be configured to run at a lower specific speed or speeds.

In a preferred embodiment, the motor **48** is an inner rotor motor, although it is permissible within the scope of some aspects of the present invention for an outer rotor motor, a dual rotor motor, or any other configuration of motor known in the art to be used.

In a preferred embodiment, the rotor **50** includes a plurality of magnets **54**, shown schematically in FIG. **5**. The magnets **54** may be of any type, including but not limited to rare earth magnets.

In a preferred embodiment, the pump assembly **14** further includes a shaft **56** rotatable about a shaft axis. Preferably, the rotor **50** includes a connection element **58** extending between and interconnecting the magnets **54** and the shaft **56** such that the rotor **50** and the shaft **56** are fixed to each other and rotate simultaneously. However, it is permissible according to some aspects of the present invention for the shaft **56** to be disposed relative to the rotor **50** in any manner by which rotation of the rotor drives rotation of the shaft. A gear and/or pulley based transmission system might be provided, for instance, to allow the shaft to be mounted remotely from the rotor.

Preferably, the shaft axis and the rotor axis are at least substantially parallel or, more preferably, at least substantially aligned. However, it is permissible according to some aspects of the present invention for such axes to be non-parallel and/or non-aligned.

In a preferred embodiment, the rotor **50** and the shaft **56** are rotatably supported in the motor portion **32** of the housing **30** by a pair of bearings **60** and **62**. The bearings **60** and **62** are secured to the housing **30** by respective rings **64** and **66**. In addition to supporting the bearings **60** and **62**, the rings **64** and **66** are preferably elastomeric and thereby configured to absorb tolerances and aid in bearing installation. As noted previously, however, the motor **48** is preferably a wet-rotor motor, with the rings **64** and **66** not being configured to form a fluid-tight seal.

Although the above-described rotor and shaft support configuration is preferred, it is permissible for any rotational support means known in the art to be used to rotatably support the rotor and shaft.

Preferably, a retainer **68** and a thrust washer **70** are positioned between the connection element **58** and the bearing **62** to absorb axial loads exerted therebetween.

The stator **52** preferably includes a core **72** and a plurality of coils **74** (shown schematically) wound about the core. The core **72** is preferably a laminated core, although non-laminated configurations are permissible, as well. The core **72** preferably extends continuously, although it may alternatively include a plurality of segments. Furthermore, although arcuate extension is preferred, such that the core **72** takes an annular or toroidal form, it is permissible for the core to define an alternative shape. Among other things, for instance, the core could define square inner and/or outer perimeters, or the core could define a circular inner perimeter and a octagonal outer perimeter.

The coils **74** preferably comprise wires comprising one or more electrically conductive materials, including but not limited to aluminum or copper. The wires may be coated or uncoated without departing from the scope of the present invention.

As illustrated schematically in FIG. **5**, the stator **52** preferably includes an electrically insulative layer **76** between the core **72** and the coils **74**. The insulative layer **76** may suitably comprise tabs, a powder coating, or any other insulation means known in the art. Furthermore, it is permissible for the stator to be non-insulated.

Additional insulation (not shown) such as stamped Mylar® may be provided as necessary between the coils of the stator and the housing, with provision of such insulation enabling the stator to be positioned closer to the housing and/or for the size of the stator compartment to be decreased. However, it is permissible for such additional insulation to be omitted.

As noted previously, the motor portion **32** preferably includes a cover **38** and a partition **40**. The cover **38** preferably includes a radially-extending, at least substantially circular end portion **78** and a side portion **80** that extends axially from the end portion **78** to at least at least substantially circumscribe the stator **52**. Preferably, a plurality of ventilation slots **82** are formed at the intersection of the end portion **78** and the side portion **80** to aid in cooling of the motor **48**. However, it is within the scope of the present invention for alternative motor portion configurations to be used. Among other things, for instance, the side portion might be circumferentially discontinuous, or the end portion and/or the side portion might be non-circular or non-cylindrical, respectively. Alternatively located or shaped ventilation slots might be provided, or the motor portion might be entirely devoid of ventilation slots.

In a preferred embodiment, the cover **38** is positioned adjacent the flow path portion **34** and is removably retained thereon. More particularly, the cover **38** is preferably attached to the flow path portion **34** by a lock mechanism **84** that is operated by relative twisting between the components. As best shown in FIG. **4**, the lock mechanism **84** preferably includes a plurality of evenly arcuately spaced apart hooks **86**. Each of the hooks **86** preferably includes a base **88** extending axially from the side portion **80** of the cover **38** and a corresponding catch **90** extending radially outwardly from the base **88**. A corresponding plurality of receivers **92**, each of which includes an opening **94** and a shelf **96**, is preferably formed on or adjacent the flow path portion **34**. For assembly, the cover **38** is preferably moved axially toward the flow path portion **34** (or vice versa) such that the hooks **86** extend through the openings **94**. Twisting or rotation of the cover **38** such that the catches **90** engage and rest upon corresponding ones of the shelves **96** then secures the cover **38** and the flow path portion **34** to each other.

Although the above-described lock mechanism is preferred, it is permissible for any attachment means, including but not limited to alternatively configured lock mechanisms, adhesives, screws, nuts and bolts, and/or snap-fit elements to be used.

In a preferred embodiment, the partition **40** extends axially between the rotor **50** and the stator **52** to at least substantially circumscribe the rotor **50**. In a preferred embodiment, the partition **40** is circumferentially continuous, although non-continuous configurations are permissible.

The partition **40** is preferably positioned relative to the side portion **80** of the cover **38** such that the core **72** of the stator **52** abuts both the partition **40** and the side portion **80**. However, alternative positioning is possible within the scope of the present invention.

In a preferred embodiment, a groove **98** is formed in the end portion **78** of the cover **38**. Preferably, a U-shaped gasket **100** is inserted in the groove **98**. The partition **40** is preferably integrally formed with and projects outwardly from the flow path portion **34** of the housing **30** toward and into the gasket **100** in the groove **98**. Preferably, the gasket **100** serves to form an at least substantially fluid-tight seal between the cover **38** and the partition **40**, such that fluid ingress into the stator compartment **44** is at least substantially prohibited.

However, the partition could be formed and/or supported in an alternative manner. Among other things, for instance, the partition might be non-integral with the flow path portion and instead affixed thereto by any means known in the art. Furthermore, the partition could alternatively project from the end portion of the motor housing, with a receiving groove and gasket being associated with the flow path portion, or the groove and/or gasket might be omitted in favor of a supporting ledge or other structure configured to provide sufficient structural support.

The flow path portion **34** of the housing **30** is preferably integrally formed and defines an inlet **102** and an outlet **104**. The flow path **46** preferably extends between and interconnects the inlet **102** and the outlet **104**. The flow path **46** preferably extends along an inlet axis **106** adjacent the inlet **102** and along an outlet axis **108** adjacent the outlet **104**.

In a preferred embodiment, the flow path portion **34** includes a linear portion **110** extending from the inlet **102** and a non-linear transition portion **112** extending between and interconnecting the linear portion **110** and the outlet **104**. However, it is permissible for the flow path portion to include more portions or only one portion.

Preferably, the flow path portion **34** defines a curve extending such that at least part of the flow path **46** extends in a direction that is oriented at an angle relative to the inlet axis **106**. In a preferred embodiment, the transition portion **112** defines the curve. Most preferably, the curved portion of the flow path terminates at the outlet **104**, with the outlet axis **108** and the inlet axis **106** defining an angle therebetween.

Preferably, the curve extends such that at least part of the flow path **46** extends in a direction that is approximately ninety (90) degrees relative to the inlet axis **106**. Most preferably, the curve in the flow path **46** extends such that the outlet axis **108** is at least substantially orthogonal to the inlet axis **106**.

However, it is within the scope of some aspects of the present invention for any of a variety of acute or obtuse angles to be defined relative to the inlet axis. More particularly, although the flow path portion **34** most preferably defines a flow path turn of approximately ninety (90) degrees, the angle of the flow path **46** may suitably be in a range from about twenty (20) degrees to one hundred sixty (160) degrees relative to the inlet axis.

It is also noted that the total angle defined in the flow path **46** is approximately ninety (90) degrees in the illustrated embodiment. It is important that some angle in the range be defined, but other angles may be defined elsewhere in the flow path. For instance, according to some aspects of the present invention, multiple turns may be defined in the flow path. Again, however, it is most preferred that the flow path **46** present a total angular relationship between the inlet and outlet axes **106** and **108**, respectively, of ninety (90) degrees.

It is also permissible for the transition portion to include a plurality of curved, straight, and/or mixed-design segments that cooperatively define at least a part of the above-described curve.

Preferably, flow path portion **34** has an at least substantially constant circular cross-section and wall thickness such that the flow path **46** has an at least substantially constant circular cross-section. However, it is permissible to incorporate a variety of modifications into the flow path portion and, in turn, vary the flow path shape and size. For instance, the flow path might include expanded, constricted, and/or alternatively shaped regions due to variations in the outer dimensions and shape of the flow path portion and/or the wall thickness of the flow path portion.

In a preferred embodiment, the flow path portion **34** includes stationary vane inserts **114** and **116** adjacent the inlet **102** and the outlet **104**, respectively. Each of the inserts **114** and **116** includes a plurality of vanes **118** configured to direct the flow of fluid as desired. Although straight and evenly spaced apart vanes **118** are shown, it is permissible for any vane shape or configuration to be utilized. It is also permissible for only one insert to be provided or for the inserts to be excluded entirely. Additional sets of vanes might be provided, and/or the vanes might be positioned elsewhere in the flow path. Still further, vanes might instead be integrally formed with the flow part portion or associated therewith in any other manner known in the art.

Preferably, a portion **120** of the shaft **56** extends through the flow path portion **34** of the housing **30** into the flow path **46**. Most particularly, the shaft portion **120** preferably extends through the transition portion **112** of the flow path portion **34** into the flow path **46**. However, it is permissible according to some aspects of the present invention for the shaft portion to extend into the flow path via an alternative route.

As noted above, the housing **30** preferably includes a sheath portion **36**. The sheath portion **36** preferably receives at least a substantial part of the shaft portion **120** positioned in the flow path **46**. In a preferred embodiment, the sheath portion **36** is circumferentially continuous so as to at least substantially circumscribe the shaft portion **120**, although non-continuous configurations are permissible.

Preferably, the sheath portion **36** projects into the flow path **46** from the flow path portion **34** of the housing **30**. Furthermore, the sheath portion **36** is preferably integrally formed with the flow path portion **34** of the housing **30**. However, the sheath portion could alternatively be non-integral with the flow path portion and instead affixed thereto by any means known in the art.

In a preferred embodiment, the pump assembly **14** includes an impeller **122** rotatable about an impeller axis. The impeller **122** preferably includes a plurality of blades **124** extending at least substantially radially from the impeller axis and configured to propel a fluid at least substantially axially thereby. The blades **124** may be pitched or shaped as required to achieve the desired flow characteristics. Preferably, the spacing of the blades **124** is such that particulate may pass between the blades **124** without jamming the impeller **122**. However, blade spacing may be varied without departing from the scope of the present invention.

Preferably, the impeller **122** is fixed to the shaft **56** to rotate therewith, with the shaft axis of rotation and the impeller axis of rotation being at least substantially aligned. However, it is permissible according to some aspects of the present invention for the axes to be non-aligned so as to be at least substantially parallel or to form an angle therebetween. It is also permissible according to some aspects of the present invention for the impeller to be mounted or disposed relative to the shaft such that rotation of the shaft indirectly drives rotation of the impeller. For instance, a gear and/or pulley-based system might be provided to interconnect the shaft and the impeller.

In a preferred embodiment, the impeller **122** is positioned in the flow path **46** adjacent the inlet **102** and, more particularly, at least in part in the linear portion **110** of the flow path portion **34**. Thus, flow through the impeller **122** is at least substantially axial.

Preferably, the impeller axis and the inlet axis **106** are at least substantially parallel or at least substantially aligned such that the outlet axis **108** and the impeller axis form an angle therebetween. Most preferably, the outlet axis **108** is at least substantially orthogonal to the impeller axis and the inlet axis **106**, with the impeller axis and the inlet axis **106** being at least substantially aligned.

As can be inferred from the above, most preferably, the rotor axis, the shaft axis, the impeller axis, and the inlet axis **106** are at least substantially aligned, with the outlet axis **108** being at least substantially orthogonal thereto.

As shown in FIGS. **1-3**, the sump **16** preferably defines a pump assembly support slot **126**, while the appliance **10** preferably includes a support insert **128** configured to be received in the slot **126**. The support insert **128** preferably defines an opening **130**. Preferably, the support insert **128** comprises rubber, although any one or more of a variety of materials may be used without departing from the scope of the present invention. The housing **30** preferably includes a support hook **132** including a projection **134** configured to be received in the opening **130**. The pump assembly **14** is thus supported in the appliance **10** at least in part by the insert **128**, which rests in the slot **126**, and the support hook **132**, which is at least in part received in the opening **130** of the insert **128**. Preferably, the support hook **132** is integrally formed with motor portion **32** of the housing **30** and, more particularly, with the side portion **80** of the cover **38** of the motor portion **32**. However, the hook might alternatively be non-integral with the housing and/or be positioned elsewhere. It is also permissible for additional means or entirely different means of supporting the pump assembly to be provided.

In operation of a preferred embodiment of the present invention, fluid flows from the tub **12** and, more particularly, from the drainage basin **18** of the sump **16**, through the supplying orifice **22**, and to the inlet **102** of the flow path portion **34** of the housing **30**. The fluid preferably flows along the inlet axis **106** at the inlet **102** and through the stationary vane insert **114** into the portion of the flow path **46** defined by the linear portion **110** of the flow path portion **34**. The motor **48** drives rotation of the shaft **56** and the impeller **122**, such that the impeller **122** propels fluid in the linear portion **110** at least substantially axially therethrough. The fluid travels in the flow path **46** along the curve defined by the transition portion **112**, then past the stationary vane insert **116**. The fluid then flows out of the outlet **104** and to the receiving orifice **24** along the outlet axis **108**. Fluid passes through the receiving orifice **24**, into the sprayer supply channel **20**, and to the sprayer arms. After ejection from the sprayer arms, the fluid is again retained in the tub **12**, and the cycle repeats.

The pump assembly **14** described above presents numerous advantages. For instance, the pump assembly **14** is operable at high speeds and with high efficiency at such speeds. Such high speed and high efficiency capabilities allow use of a smaller pump assembly **14** than would otherwise be required to achieve the desired performance in the appliance **10**. Use of a smaller pump assembly **14** may in turn lead both to cost savings and to reduced noise.

These advantages, in combination with geometric advantages provided by the small envelope required for the preferred design, may also enable use of the pump in assembly **14** in applications in which a different type of pump assembly is typically used. For instance, many conventional household appliances utilize radial-flow centrifugal pumps driven by fixed speed motors having two pole motor speeds between 3,000 rpm and 3,600 rpm. Variable speed motors with slightly higher maximum speeds are also known to be used in appliances and are also often used to drive radial-flow centrifugal pumps. Typically, liquid orifice positions and surrounding structures of the appliance are designed to accommodate the selected type of pump and motor. At least in part due to restrictions such as those described above, if replacement of an existing pump assembly is necessary or desired, such replacement is typically done using a pump assembly of the same general type. For instance, in a dishwasher having a first radial-flow centrifugal pump assembly, replacement of the first pump assembly would typically be with a second radial-flow centrifugal pump assembly. However, the performance and noise characteristics of the pump assembly **14**, in coordination with its size and configuration, make it well suited for use as a pump assembly in a conventional appliance such as that described above. More particularly, for certain conventional appliances, the pump assembly **14** is configured to fit in the envelope provided for the original radial-flow centrifugal pump assembly, to connect easily to the sump of the conventional appliance, and to enable equal or better appliance performance than was achieved using the radial-flow centrifugal pump assembly.

In an alternative application, the pump assembly **14** is well suited for use as an original pump in an appliance originally designed for use with a radial-flow centrifugal pump assembly. That is, an original equipment manufacturer could transition from creating appliances having radial-flow centrifugal pumps assembles to creating appliances having pumps assemblies such as pump assembly **14** without significant redesign.

The preferred forms of the invention described above are to be used as illustration only and should not be utilized in a limiting sense in interpreting the scope of the present invention. Obvious modifications to the exemplary embodiments, as hereinabove set forth, could be readily made by those skilled in the art without departing from the spirit of the present invention.

The inventors hereby state their intent to rely on the Doctrine of Equivalents to determine and assess the reasonably fair scope of the present invention as pertains to any apparatus not materially departing from but outside the literal scope of the invention set forth in the following claims.

What is claimed is:

1. A household appliance comprising:

a tub configured to contain a liquid; and

a pump assembly for effecting liquid flow within the tub, said pump assembly including:

a housing including a motor portion and a flow path portion,

said flow path portion being integrally formed and defining an inlet, an outlet, and a flow path extending between and interconnecting the inlet and the outlet,

at least one of said inlet and said outlet being fluidly coupled to the tub,

said flow path extending along an inlet axis of the inlet and along an outlet axis of the outlet,

said flow path portion defining a turn, such that at least part of the flow path extends in a direction that is oriented at an angle relative to the inlet axis,

a motor including a rotor and a stator, with the stator being fixed relative to the motor portion,

at least part of said motor portion being integrally formed with the flow path portion and defining a rotor compartment in which the rotor is rotatably disposed,

said rotor compartment and said rotor being spaced from the flow path,

an impeller rotatable about an impeller axis,

said impeller including a plurality of blades extending at least substantially radially from the impeller axis and configured to propel a fluid along the flow path,

wherein said impeller is positioned in the flow path closer to the inlet than the outlet, with the impeller axis and the inlet axis being at least substantially parallel or at least substantially aligned, and

a rotatable shaft extending between and operably interconnecting the rotor and the impeller to transmit rotation of the rotor to the impeller,

said rotor compartment being fluidly connected to the fluid path so as to present a wet rotor design,

said motor portion including a cover and a partition,
said cover at least substantially circumscribing the stator,
said partition extending between the rotor and the stator to at least substantially circumscribe the rotor,
said cover being removably retained on the flow path portion,
said partition being integrally formed with the flow path portion, such that said at least part of the motor portion includes the partition.

2. The appliance as claimed in claim **1**,
said shaft being rotatable about a shaft axis.

3. The appliance as claimed in claim **2**,
said shaft axis and said impeller axis being at least substantially parallel or at least substantially aligned, such that the shaft axis and the outlet axis define an angle therebetween.

4. The appliance as claimed in claim **2**,
said impeller being fixed to the shaft to rotate therewith,
said shaft being fixed to the rotor to rotate therewith.

5. The appliance as claimed in claim **2**,
a portion of said shaft extending through the flow path portion of the housing into the flow path.

6. The appliance as claimed in claim **5**,
said housing further including a sheath portion,
said sheath portion receiving at least a substantial part of the shaft portion positioned in the flow path.

7. The appliance as claimed in claim **1**,
said outlet axis being at least substantially orthogonal to the inlet axis and the impeller axis.

8. The appliance as claimed in claim **1**,
said flow path portion including a linear portion extending from the inlet,
said impeller being positioned at least in part in the linear portion.

9. The appliance as claimed in claim **8**,
said flow path portion including a non-linear transition portion extending between and interconnecting the linear portion and the outlet,
said non-linear transition portion defining a curve extending such that the outlet axis is at least substantially orthogonal to the impeller axis and the inlet axis.

10. The appliance as claimed in claim **1**,
said motor being a three-phase, brushless permanent magnet motor.

11. The appliance as claimed in claim **1**,
said outlet defining the at least part of the flow path, such that the inlet axis and the outlet axis define an angle therebetween.

12. An appliance pump assembly for effecting liquid flow within a tub of the appliance, said pump assembly comprising:
a housing including a motor portion and a flow path portion,
said flow path portion being integrally formed and defining an inlet, an outlet, and a flow path extending between and interconnecting the inlet and the outlet,
at least one of said inlet and said outlet being fluidly coupled to the tub,
said flow path extending along an inlet axis of the inlet and along an outlet axis of the outlet,
said flow path portion defining a turn, such that at least part of the flow path extends in a direction that is oriented at an angle relative to the inlet axis,
a motor including a rotor and a stator, with the stator being fixed relative to the motor portion,
at least part of said motor portion being integrally formed with the flow path portion and defining a rotor compartment in which the rotor is rotatably disposed,
said rotor compartment and said rotor being spaced from the flow path,
said rotor compartment being fluidly connected to the fluid path so as to present a wet rotor design;
an impeller rotatable about an impeller axis,
said impeller including a plurality of blades extending at least substantially radially from the impeller axis and configured to propel a fluid along the flow path,
wherein said impeller is positioned in the flow path closer to the inlet than the outlet, with the impeller axis and the inlet axis being at least substantially parallel or at least substantially aligned; and
a rotatable shaft extending between and operably interconnecting the rotor and the impeller to transmit rotation of the rotor to the impeller,
said motor portion including a cover and a partition,
said cover at least substantially circumscribing the stator,
said partition extending between the rotor and the stator to at least substantially circumscribe the rotor,
said cover being removably retained on the flow path portion,
said partition being integrally formed with the flow path portion.

13. The appliance pump assembly as claimed in claim **12**,
said shaft being rotatable about a shaft axis.

14. The appliance pump assembly as claimed in claim **13**,
said shaft axis and said impeller axis being at least substantially parallel or at least substantially aligned, such that the shaft axis and the outlet axis define an angle therebetween.

15. The appliance pump assembly as claimed in claim **13**,
said impeller being fixed to the shaft to rotate therewith,
said shaft being fixed to the rotor to rotate therewith.

16. The appliance pump assembly as claimed in claim **13**,
a portion of said shaft extending through the flow path portion of the housing into the flow path.

17. The appliance pump assembly as claimed in claim **16**,
said housing further including sheath portion,
said sheath portion receiving at least a substantial part of the shaft portion positioned in the flow path.

18. The appliance pump assembly as claimed in claim **12**,
said outlet axis being at least substantially orthogonal to the inlet axis and the impeller axis.

19. The appliance pump assembly as claimed in claim **12**,
said flow path portion including a linear portion extending from the inlet,
said impeller being positioned at least in part in the linear portion.

20. The appliance pump assembly as claimed in claim **19**,
said flow path portion including a non-linear transition portion extending between and interconnecting the linear portion and the outlet,
said non-linear transition portion defining a curve extending such that the outlet axis is at least substantially orthogonal to the impeller axis and the inlet axis.

21. The appliance pump assembly as claimed in claim **12**,
said motor being a three-phase, brushless permanent magnet motor.

22. The appliance pump assembly as claimed in claim **12**,
said outlet defining the at least part of the flow path, such that the inlet axis and the outlet axis define an angle therebetween.

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